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EFFECT OF HANDLING AND PROCESSING METHODS ON THE FIRMNESS AND QUALITY OF CANNED AND FROZEN RED CHERRIES[1]

By C. L. BEDFORD and W. F. ROBERTSON
DEPARTMENT OF HORTICULTURE

IN RECENT YEARS the cherry industry has been plagued with red cherries that lack firmness at harvest time and that do not firm up during soaking. These soft cherries are hard to pit without tearing or crushing, and they often end up in a mutilated condition in the can.

These changes in cherry firmness cannot be attributed to any one area or orchard, since in any given orchard cherries may be firm one year and soft the next.

Apparently, the firmness or strength of the cherry structure is influenced by the growing conditions; the principal factors involved seem to be water, temperature, humidity, and nitrogenous fertilizer. Usually, too much water or nitrogen results in the production of soft cherries, particularly when during the 3- or 4-week period immediately prior to harvest there is a combination of above-normal rainfall and nearly normal temperature.[2]

This study was conducted to determine the effect of variations in soaking methods on the firmness and quality of canned and frozen cherries; it also sought to determine the effect of various additives on the texture and quality of canned cherries.

EXPERIMENTAL METHODS

Montmorency cherries, grown and harvested commercially in the various cherry growing areas of Michigan, were used. In every case,

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[1] A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract was supervised by the Eastern Utilization Research and Development Division, Agricultural Research Service.

[2] Bedford, C. L., and W. F. Robertson (1955). Effect of various factors on the drained weight of canned red cherries. Food Tech. 9: 321-323.

we tried to obtain both normal and soft cherries. In addition, cherries were obtained from a representative block of trees that had been given an additional 5 pounds of urea per tree during the blossoming period to determine if higher nitrogen fertilization produced soft cherries.

The cherries were transported by truck to the Michigan State University Food Technology laboratory. On arrival, they were weighed and placed in soaking tanks or stored in air at 2° C. (35° F.).

Representative lots of the various treatments were removed at various intervals, drained, sorted, and the sound fruit pitted in a Dunkley cherry pitter of pilot plant capacity. The pitted cherries were canned in No. 2 cherry enamel cans or frozen in pint Marapak bags in cartons. In the canning studies, 16 ounces of pitted cherries were filled into each can, covered with hot water or sirup, exhausted for 7 minutes, processed in boiling water for 12 minutes, cooled, and stored at 10°C. (50° F.). For freezing, the pitted cherries were packed with dry sugar (5+1), frozen at about –23° C. (–10° F.), and stored at –18° C. (0° F.).

Cooling Treatments

Cherries were soaked in water at average temperatures of 5.5° C. (42° F.) and 2° C. (35° F.) and in .05, .10 and .15 percent $CaCl_2$ solutions at 2° C. (35° F.) for 6 to 24 hours. Cherries were also cooled in air at 2° C. (35° F.) for 6 to 24 hours.

Additive Treatments

Calcium. The effect of calcium ions on the intercellular cement is well known[3,4]. Cherries soaked in water at 5.5° C. (42° F.) for 6 hours were graded, pitted, and canned in water to which calcium chloride, lactate, gluconate, sulfate, and citrate were added. In each instance, enough salt was added to obtain 13.5, 54 and 135 milligrams (mg.) of calcium per No. 2 can.

Sugar. Cherries were canned with 0.5, 1.0, 1.5 and 2 ounces of dry sugar per can, with 10, 15, 20 and 25 percent sucrose sirup, and with sirup mixtures in which 30 percent of the sucrose solids were replaced by corn sirup (dextrose equivalent of 63 percent).

Pectin. Sixty, 600 and 1,200 mg. of 170 grade pectin, with and without the addition of 0.5 and 1.0 ounce of sugar, were added to the canned

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[3] Kertesz, Z. I. (1939). The effect of calcium on plant tissues. Canner 88: 26-27.
[4] True, R. H. (1952). Significance of calcium in higher green plants. Science 55: 1-2.

cherries. Other cans were packed with the addition of 60 mg. of low methoxy pectin and with 13.5 and 54 mg. of calcium, respectively.

RESULTS

Cooling Methods

There were no significant differences between the pit, juice, or pitter losses, although there was a tendency for all of them to be slightly higher in the calcium chloride-soaked cherries. This resulted in a significantly lower yield of pitted cherries (Table 1). The drained weight of the air-cooled cherries was significantly higher than that of the $CaCl_2$ soaked cherries. No differences were obtained for the frozen cherries.

TABLE 1—Effect of cooling methods on red cherries

Properties	Cooling and soaking treatments(a)					L.S.D.(b)	
	Water		Air	$CaCl_2$ solution	F. value		
	42°F.	35°F.	35°F.	35°F.		5%	1%
Pit loss (%)	7.6	7.7	7.8	7.9	1.08	..	..
Juice loss (%)	6.1	5.8	5.5	6.6	2.84	..	..
Pitter loss (%)	3.0	2.7	2.7	3.6	2.94	..	..
Yield, pitted fruit (%)	83.3	84.1	83.6	82.0	6.18**	1.0	1.4
Drained wt., canned (oz.)	13.9	14.0	14.4	14.2	6.20**	.11	.15
Drained wt., frozen (oz.)	9.7	9.7	9.8	9.7	0.85	..	..
Tenderometer, cooled (lb./sq. in.)	31	31	31	33	3.88*	1.4	..
Tenderometer, canned (lb./sq. in.)	18	17	16	17	1.79	..	..
Tenderometer, frozen (lb./sq. in.)	40	41	39	40	0.70	..	..

(a) Mean values of 12 to 16 determinations.
(b) Least significant difference.
*Significant at 5 percent level.
**Significant at 1 percent level.

Although the tenderometer values of the $CaCl_2$-soaked cherries were higher before processing, no differences due to cooling methods were obtained in either canned or frozen fruit.

Cooling Times

The pit loss and yield of pitted cherries was higher for the cherries cooled for 12 and 24 hours, while the juice loss became less as the cooling time increased (Table 2). The cooling time had no effect on pitter loss or drained weights. The tenderometer values increased with increased cooling time.

TABLE 2—Effect of cooling time on red cherries

Properties	Time in hours(a)				F. value	L.S.D.(b)	
	0	6	12	24		5%	1%
Pit loss (%)	7.6	7.6	8.0	7.8	4.90**	.23	.31
Juice loss (%)	6.8	6.3	5.8	5.5	6.67**	.51	.68
Pitter loss (%)	2.9	3.2	2.8	2.9	2.74	..	...
Yield, pitted fruit (%)	82.7	82.4	83.9	83.9	6.66**	1.04	1.39
Drained wt., canned (oz.)	14.0	14.0	14.0	14.1	1.05	..	..
Drained wt., frozen (oz.)	9.8	9.6	9.7	9.7	1.80	..	..
Tenderometer, cooled (lb./sq. in.)	30	31	32	32	7.08**	1.3	1.7
Tenderometer, canned (lb./sq. in.)	16	17	18	18	3.09*	1.7	..
Tenderometer, frozen (lb./sq. in.)	37	39	41	43	15.95**	1.8	2.3

(a) Mean values of 12 to 16 determinations.
(b) Least significant difference.
*Significant at 5 percent level.
**Significant at 1 percent level.

Normal vs. Soft Cherries

Since the results for the cherries from the higher nitrogen-fertilized trees were similar to those obtained for the soft cherries from commercial orchards, the data were combined for presentation.

The pit and pitter losses were similar for both normal and soft

TABLE 3—Comparison of normal and soft cherries(a)

Properties	Normal	Soft	F. value	L.S.D.(b)	
				5%	1%
Pit loss (%)	7.7	7.8	1.60	....	....
Juice loss (%)	5.9	6.7	13.68**	.30	.39
Pitter loss (%)	3.0	3.0	.02	....	....
Yield, pitted fruit (%)	83.6	83.0	2.61	....	....
Drained weight, canned (oz.)	14.1	13.9	6.78**	.09	.13
Drained weight, frozen (oz.)	9.7	9.6	1.56	....	....
Tenderometer, soaked (lb./sq. in.)	33	30	26.8**	.93	1.23
Tenderometer, canned (lb./sq. in.)	20	17	21.73**	1.02	1.35
Tenderometer, frozen (lb./sq. in.)	42	39	6.29*	1.5	....

(a) Mean values of 12 to 16 determinations.
(b) Least significant difference.
* Significant at 5 percent level.
** Significant at 1 percent level.

cherries (Table 3). Juice loss of the soft cherries was significantly higher than that of the normal cherries. The yield, drained weights, and tenderometer values were all higher for the normal cherries. However, only the drained weights of the canned cherries, and the tenderometer values of the soaked, canned and frozen fruit showed significant differences.

Additive Treatments

Calcium. The addition of the various calcium salts at three levels of calcium had no effect on the drained weights (Table 4). The drained weights of the soft cherries were lower than those of the normal cherries.

TABLE 4—Effect of calcium salt additions on drained weight(a)

Salt	Cherries(b)	Ca concentration: mg. per No. 2 can				
		0	13.5	54	135	Average (oz.)
		Drained weight (ounces)(c)				
Ca chloride	Firm	14.0	13.5	14.0	13.9	13.9
	Soft	13.9	13.8	13.8	13.8	13.8
Ca lactate	Firm	14.0	14.2	13.9	13.9	14.0
	Soft	13.9	13.9	13.8	13.9	13.9
Ca gluconate	Firm	14.0	14.0	14.0	14.0	14.0
	Soft	13.9	13.6	13.8	13.6	13.7
Ca sulfate	Firm	14.0	14.0	14.0	14.0	14.0
	Soft	13.9	13.7	13.6	13.8	13.8
Ca citrate	Firm	14.0	14.0	14.0	14.0	14.0
	Soft	13.9	13.7	13.7	13.8	13.8

(a) Put-in weight 16 ounces.
(b) Difference required between firm and soft cherries: 5 percent, .05; 1 percent, .07.
(c) Mean values of 12 to 16 determinations.

The tenderometer values of the canned cherries increased with greater Ca concentrations in both lots of cherries; the larger increases occurred in the firm cherries (Table 5). In general, there were no differences between the calcium salts, indicating that the firming effect was directly related to the concentration of calcium.

Sugar. The drained weights of the cherries packed with dry sugar plus water were higher than the water pack, while those packed with sirup were similar to the water pack (Table 6). No significant differences were obtained between the normal and soft cherries. In general, canning with sugar increased the tenderometer values

TABLE 5—Effect of calcium salt additions on tenderometer values

Salt	Cherries(*b*)	Ca concentration(*a*): mg. per No. 2 can: 0	13.5	54	135	Average
		Tenderometer values (lb./sq. in.)(*c*)				
Ca chloride...	Firm.......	18	20	22	29	22
	Soft.......	17	17	19	21	19
Ca lactate.....	Firm.......	18	22	25	30	24
	Soft.......	17	16	18	21	18
Ca gluconate..	Firm.......	18	18	21	29	21
	Soft.......	17	15	18	21	18
Ca sulfate....	Firm.......	18	20	22	26	21
	Soft.......	17	16	17	19	17
Ca citrate.....	Firm.......	18	22	28	24	23
	Soft.......	17	15	17	23	18

(*a*) Difference required between concentrations: Firm 5 percent, 2.2; 1 percent, 2.9. Soft 5 percent, 1.0; 1 percent, 1.4.
(*b*) Difference required between firm and soft cherries: 5 percent, 1.3; 1 percent, 1.7.
(*c*) Mean values of 12 to 16 determinations.

over the water pack. The results obtained with the packs in which 30 percent of the sucrose solids were replaced with corn sirup were similar to the straight sucrose sirup packs; therefore, they are not given separately.

Pectin. The addition of pectin did not have any beneficial effect on the texture and quality of the canned cherries. It produced an unattractive appearing product, particularly at the higher concentrations, due to the formation of a gel.

TABLE 6—Effect of sugar packs on canned red cherries

Treatment	Drained weight (oz.): Firm fruit	Drained weight (oz.): Soft fruit	Tenderometer (lb./sq. in.): Firm fruit	Tenderometer (lb./sq. in.): Soft fruit
Water........................	14.0	13.9	18	17
0.5 oz. sucrose plus water.......	14.1	14.1	23	24
1.0 oz. sucrose plus water......	14.1	13.8	20	20
1.5 oz. sucrose plus water......	14.2	14.1	25	21
2.0 oz. sucrose plus water......	14.3	14.1	26	20
10% sucrose sirup............	13.9	13.9	23	21
15% sucrose sirup............	13.8	13.7	18	17
20% sucrose sirup............	13.6	13.8	19	21
25% sucrose sirup............	13.8	14.0	20	20
Average.................	14.0	13.9	21	20

DISCUSSION AND SUMMARY

Whittenberger[5] reported that the edible tissues of the red cherry are composed of thin-walled cells cemented together with pectic substances. If both are strong, the cherry is firm and gives a high drained weight; if one or both are weak, tissues are soft and drained weight is low.

Although it has not been possible to definitely establish the conditions under which the structural strength of the cherry is modified, it does appear that it is greatly influenced by the growing conditions. Under certain climatic conditions, too much water or nitrogen fertilizer will usually result in soft cherries.

As previously reported,[6] under weather conditions of above normal rainfall and nearly normal temperature, lower drained weights were obtained and the cherries were less firm. Too much nitrogen fertilizer also tended to produce soft cherries when there was enough moisture for rapid absorption of the nitrogen. This, however, apparently does not occur at below-normal rainfall or above-normal temperature conditions.

Unfortunately, the above factors cannot be controlled in commercial practice. Therefore, the handling, storage and processing techniques, and the possibility of the use of additives to improve the firmness and quality of soft red cherries were considered.

The data obtained showed that the drained weights of canned cherries could be increased by air-cooling, by soaking in calcium solutions, and by canning with dry sugar. Canning the cherries with various added calcium salts, with sugar sirups, or with pectin had no effect on the drained weights.

The firmness of the processed cherries was similar for all cooling treatments; all increased with lengthened cooling time. Although cooling methods had no effect on the processed cherries, the cherries soaked in calcium solutions were firmer before processing than were either the water- or air-cooled cherries. This suggests the possibility of adding calcium to the soak water to increase firmness and eliminate, at least partially, the loss due to the tearing or crushing during pitting.

The addition of calcium to the cherries before processing increased their firmness; and this increase was directly related to the

[5] Whittenberger, R. T. (1952). Factors which affect the drained weight and other characteristics of heat-processed red cherries. Food Res. 17: 299-306.

[6] Bedford and Robertson. Op. cit.

calcium concentration. Canning with sugar or sugar sirup also increased the firmness of the fruit, with dry sugar being more effective than the sirup.

The results indicate that the firmness and quality of the product could be improved (particularly in the case of soft fruit) by soaking the cherries in calcium solutions and by canning with added calcium and/or sugar. The taste panel evaluations on pies made from the various treatments indicated that canning with sugar or sugar sirup made the more acceptable product.